CLMCF 1.4v1 3/4/97

APPENDIX E/F. STREAM CHANNELS AND FISH HABITAT

1.0 INTRODUCTION

The Department of Natural Resources Forest Practices Division has granted one-time approval to the Onion Creek Assessment Team to combine into one analysis report both the Channel and Fish Habitat Assessment reports (Shaw, October, 1996). This format modification was attempted to ensure consistency of interpretive channel/fish results brought to the synthesis and prescription phases and to minimize the duplication of effort and work products. Level 2 assessment methods for both modules were used and standard or equivalent work products are supplied.

1.1 Channel Assessment Overview

The purpose of the channel assessment is to provide an understanding of the current and possible future states of channel conditions. The objectives are to develop information to establish:

- Which *channel segments are likely to respond similarly* to changes in the input factors of water, sediment, and wood.
- *Historical changes* in channel morphology to identify past and continuing natural processes and management-related impacts.
- The *current condition of channels* indicating the present status and potential direction of channel changes relative to the input factors.
- The *channel sensitivity or likely future response* relative to the input factors given the nature of the channel and its present condition.
- Channel processes influencing *habitat attributes* identified as important for fish or other aquatic organisms.

An important element of the assessment is to stratify the watershed into areas of similar condition and response, ultimately relating channel form and process to the terrain, geology, and disturbance history. This allows an assessment of channel conditions on a watershed scale and provides a basis for understanding the influence of changes in land management on channel conditions and processes and, therefore, aquatic resources.

The channel assessment is conducted using maps, aerial photographs, field observations, and other available data. In the text below, methods and results are described and related to the objectives above. Confidence in the analysis is addressed within each section or step, as required in the methods manual.

1.2 Fish Habitat Assessment Overview

The goal of the fish assessment is to locate accessible fish habitat in the watershed and to identify existing conditions and habitats of special concern. The objectives of the fish assessment are:

- Identify the *distribution and relative abundance* of salmonid fish species.
- Identify *historic trends in fish abundance* by stock.
- Determine *existing habitat conditions.*
- Evaluate distribution changes, abundance trends, and existing habitat conditions to *identify degraded habitats.*
- Evaluate *habitat utilization and habitat preference* information to identify high use areas and habitats of limited availability.

The fish habitat assessment is conducted using maps, available habitat and population survey information, field observations, and other available data. In the text below, methods and results are described and related to the objectives above. Confidence in the analysis is addressed within each section or step, as required in the methods manual.

2.0 STREAM CHANNEL ANALYSIS

2.1 Watershed Overview

This section offers an overview of the physiographic, geologic, and climatic factors shaping the Onion Creek stream system. Onion Creek is a fifth-order basin (Strahler classification; Strahler, 1957) joining the Columbia River on the left bank 14 miles downstream from the Canadian border. The Onion Creek WAU (Watershed Administrative Unit) includes 34,481 acres draining to Onion Creek and an additional 11,981 acres of sideslope drainage parallel to the Columbia River (Figure 2, main document). Maximum relief in the basin is 4,465 feet.

Bedrock geology includes marine metasedimentary rocks and granite (Figure 4, main document). The landforms of Onion Creek are shown in Figure A-1 (Appendix A) and are useful in the interpretation of both hillslope and channel processes. All of the Onion Creek WAU was overridden by Pleistocene continental ice which scoured the higher ridges and slopes, mantled sideslopes with till, and filled the valleys with deep glacial sediments. Areas of metamorphic rock form the higher elevation ridges on the southern and northern ends of the watershed. Subdued hills and the deeper glacial deposits are found in the middle portion of the basin underlain by granite.

The average annual precipitation is 22 inches of which 40 to 45 percent falls as snow. Spring snowmelt runoff is largely responsible for defining channel geometry. Runoff is shed quickly from the steeper ridges and sideslopes of exposed bedrock or shallow soils into the deep, glacial soils. Perennial streams are found in the mainstem and major tributaries valleys and where the smaller tributaries have sufficient drainage area. Only an estimated 37 percent of mapped streams flow perennially.

A steep, bedrock falls located about one mile from the mouth divides the upland area from the lower portion of the watershed that lies within the deeply-scoured Columbia River Valley. The portion of the WAU within the Columbia River Valley includes both glacially-scoured bedrock sidewalls and glacial terraces at several elevations. Onion Creek below the falls flows through an alluvial fan-terrace complex. The lower 500 feet of Onion Creek is periodically flooded due to the fluctuating level of Lake Roosevelt. Of the numerous small tributaries draining the side slopes of the Columbia River, only Fivemile Creek south of Northport empties directly into Lake Roosevelt. The remaining tributaries flow subsurface upon discharging onto the terraces or quickly shed runoff from exposed bedrock slopes adjacent to the Columbia. Portions of a glaciofluvial terrace extend into Onion Creek above the falls.

Mass wasting occurs very infrequently within the WAU. Sources of sediment input to the channels are limited to bank erosion and surface erosion of the soils and alluvial floodplains and unpaved roads. Both the glacial till soils and residual granitic soils provide a source for abundant coarse sand found within many channel segments. Soils tend to be siltier in the northeast portion of the watershed in proximity to metasedimentary bedrock, trending to a higher sand content to the southwest where underlain by granite.

2.2 Methods

Methods employed for this level 2 assessment were those prescribed in version 3.0 of the Standard Methodology for Conducting Watershed Analysis (Washington Forest Practices Board, 1993). The majority of channel surveys were conducted with the fish module analyst, who collected the wood counts and pool frequency data.

A certain amount of duplication was found between forms E-4, E-5, and E-6. Formats for those products in this analysis differ slightly from the suggested formats in an effort to improve the efficiency of both the analysis and technical review. Table E/F-1 lists the forms required from the analysis in the methodology and the comparable products found in this analysis.

2.3 Channel Segments

Following a field reconnaissance of basin streams in early September, 1996, the first effort at characterizing channels began with partitioning them into segments based on gradient class and valley confinement. The combination of gradient and confinement provides a simple method to initially estimate response potential and can be done from either topographic maps, aerial photographs, or digital terrain data. This initial classification also helps in the selection of representative channel segments for field observation.

A total of 102 numbered channel segments were created for the Onion Creek watershed based on the channel reconnaissance, topographic maps, and 1992 aerial photographs. Segment breaks and and numbering were subsequently refined as a result of the field surveys (Section 4.0). A number of minor or ephemeral channels where not numbered, although a percentage of these were field checked. Channels originally mapped on the state hydrologic layer but found without a defined channel during field work were removed from the map. We anticipate that additional unnumbered segments may be removed from the water layer as these are field checked in the future. With the removal of the field checked non-channels, the drainage density within the WAU is 1.9 mi/mi^2.

Segment numbering provides a reference system also used in the riparian and fish habitat assessments and during the synthesis portion of the analysis. The mainstem channel segments of Onion Creek are numbered beginning with the number 1. Tributary systems are numbered beginning at the mouth of each creek using 3 digit numbers (Map E-1/F-1). Small tributaries draining middle mainstem side slopes were numbered 50 through 53. One segment was further subdivided following field work using the numbering sequence of the riparian analyst (801-4) to prevent renumbering existing data.

Segment breaks are approximate and were occasionally located coincident with tributary junctions to simplify mapping. Differences between segment breaks and fish use may represent either a channel change significant only to fish use, such as quantity of water, or an uncertainty in the exact map location of a change in channel morphology significant to fish use.

Form E-1 from the methods manual shows the initial distribution of channel segments by gradient and confinement classes. Unnumbered channel segments were tallied in the appropriate class. This display of channel segments is useful in selecting field sample locations representative of preliminary groupings of similar channel types. For the Onion Creek WAU, the presence or absence of perennial flow was an additional, overriding consideration in the final grouping of channel segments.

2.4 Historic Trends

A series of historical aerial photographs were examined for indicators of changes in channel conditions. Analysis from aerial photography offers a large-scale view of changes in channel morphology, such as channel widening, migration, and bar development or vegetation. The historical analysis also provides an indicator of past channel response and offers another means of focusing the field effort. The photograph series available for the Onion Creek WAU include:

1968 (1:22,580)
1980 (1:14,400)
1987 (~1:12,000)
1992 (~1:15,000)
1995 (1:214,025)

Trends in historic channel conditions were recorded on Form E-2, channel disturbance worksheet. Even under sparse and immature canopy in the 1968 photos, the majority of channels are not visible. Only those segments registering changes visible in the photographs or adjacent areas of potential land-use impacts are listed on Form E-2.

Channelization of approximately 3,000 feet of mainstem segment 2 near the mouth of Onion Creek is visible in the earliest photographs. The single tree-width of riparian vegetation appears to mature over time suggesting that the channelization may have occurred 10 to 20 years prior to 1968.

The singular channel disturbance event of note appears in the 1968 photographs in the immediate vicinity of the Van Stone Mine. A slope failure on the right bank opposite the upper tailings pond propagates down the channel and is visible as a bright, widened channel corridor all the way to the confluence of the West Fork of Onion Creek (includes segments 505, 503, 502, 501, 10, and 9). Regrowth of riparian vegetation occurs in succeeding photographs in these segments. From 1980 to 1987, however, gravel bars and bank erosion are visible in downstream, lower gradient segments 4 and 7. It is possible that sediment from the earlier disturbance is transporting through these more responsive channels 10+ years following that event. The disburbance may also be related to major storm or snowmelt runoff events. A portion of the upper-middle segment 7 channel is also accessible to cattle, which may contribute to the visible channel disturbance. A portion of this field surrounding the channel appears to have been fenced beginning in the earliest photos (1968).

From the photographs, agricultural activities and homesites appear concentrated in the mid to upper portion of the mainstem valley in proximity to the paved county road and where the glacial and valley terraces and gentle sideslopes are suitable for grazing and limited crop production. Between the 1968 and 1987 photos, there was a visible increase in the number of homesites within the watershed. Channels and wet swale areas are visible in the open, agricultural areas, but only localized evidence of erosion or disturbance aside from stock pond trenching was noted. Maintenance ditching of wet fields does not occur frequently or appear to promote long term erosion.

Forest harvest activities are evident in many portions of the WAU. Locations of potential channel disturbance include segment 602, where in 1980 it appears that logging occurred either in or immediately adjacent to the channel for some 3,000 feet and in the upper headwaters of the West Fork. The upper West Fork area experienced intensive, select harvest, and the skid trail density made it difficult to detect channels or the extent of any disburbance. A logging road in segment 203 also appears to displace that small channel for the distance to the headwater wetland.

A limited picture of changes in channel conditions over time in Onion Creek is provided by evaluation of aerial photography. Limiting factors include the short time period covered by the available photography (28 years), the small scale on the earliest and latest photos, and the small size of the majority of streams in the basin. Photos in the basin do not pre-date mining, forest harvest, or early agricultural activities, which limits the detection of major channel changes due to most land use activities. Because of the small size of these channels, the majority of channel disturbance visible from photographs is within the open areas. Confidence in detecting anything but large-scale channel disturbance from this portion of the analysis is low.

2.5 General Channel Conditions

Based on the preliminary analyses above and additional stream survey data, representative channel segments were observed in the field to evaluate current channel conditions. These included key features of the streambed, active channel, and flood plain attributes useful for interpreting channel condition and response potential. Interpretations of the reference segments were then extrapolated to other segments similar in valley and landform where field surveys were not conducted.

Approximately 1.4 miles of stream were intensely surveyed as part of this analysis, primarily in the fish-bearing streams. Numerous reconnaisance surveys and spot checks were also conducted. Many of the field-verified segments were conducted by both the channel and fish habitat analysts. Other team analysts also contributed to observations of general channel characteristics. Overall, field surveys and observations of approximately 57 percent of the numbered channel segments were used in this analysis. Approximately 50 unnumbered channels were also field checked, and the majority of these were found to have no defined channel and removed from the channel map. Channel attributes from the surveys are summarized by segment in Form E-5 found at the end of this report.

Since the results of the field surveys were used to group segments into geomorphically similar units, a narrative discussion on channel condition interpretations is included in the description for each channel grouping found in Section 4.0 below. Some general statements regarding basin channel conditions are made here.

The first mile of Onion Creek below the fish barrier at the falls is accessible to spawning adfluvial species from Lake Roosevelt. The lower 500 feet of the stream is periodically flooded due to fluctuating lake levels. Above this point, the majority of channel has been straightened through a field and on either side of the cement box culvert under the state highway. The local conservation district apparently provided for the agricultural drainage by cabling logs into the banks along approximately 2,500 feet of channel. Installation of the cabled logs predates the earliest photos available to the assessment team, and could be as early as the mid 1930's. The plane bed morphology along this segment provides little structure necessary for the storing and sorting of spawning gravel and holding habitat.

Localized evidence of land use impacts to fish-bearing channels are found above the falls. A major disturbance occurred in the tributary adjacent to the Van Stone Mine due to an apparent tailings pipe-burst or associated slope failure prior to 1968. The channel immediately below this site remains a boulder cascade devoid of any functional wood in contrast to the step-pool morphology above. Mainstem segments 7 and 10 are point sources of extensive bank erosion and open canopy due to stream access to livestock. Both county and forest roads encroach upon channels with impacts ranging from a reduction in wood availability to sediment overloading in the small tributaries. Road dust from carbonate soils was found to cement the bed surface in segment 202 adjacent to a well-traveled, gravel county road. Harvest activities prior to 1980 along segment 602 has reduced wood recruitment along the left bank.

Wood is important for providing the majority of structure to mainstem and major tributary segments. The majority of these channels fall within a 2 to 4 percent gradient range, which are prone to establishing long riffles in the absence of wood. Overall, woody debris of a size sufficient to function in these channels currently appears to be in adequate supply with a corresponding area in pools (see Section 3.3.3). Within some of the more open areas, however, wood is supplied by failed beaver dams and wood exhumed from the banks of former beaver ponds. This wood is limited in supply and in various stages of decomposition. Current beaver activity was observed by the team in just a few areas compared to widespread evidence of past activity. Additional structure is also provided by glacial lag boulders, particularly in the smaller tributaries.

Pool filling with fine sediment was inconsistent within segments. Coarse sand/fine gravel filling was found to a depth of 0.4 feet in 6 out of 16 pools in segment 4. The remaining pools had little if any filling. The bed surface of most fish-bearing segments was described as bi-modal due to the abundance of granitic coarse sand and fine gravel observed during the field surveys.

The fish habitat analyst noted very few patches of sorted spawning gravel in most reaches. In addition, the larger substrate particles in both the mainstem and tributaries were frequently found to be 40 to 50 percent embedded with the finer gravels, resulting in few interstitial spaces for winter refuge and rearing. These conditions exist in spite of relatively good habitat indices and wood loading. Several factors may contribute to this condition. These include an oversupply of a certain size-fraction of sediment within the channels, angularity of the coarse bedload, and the timing of field observations relative to periodic sediment flushing flows. The majority of parent material available within the stream system is composed of glacial till high in angular sand and small gravel of granitic origin which may currently, or naturally, be in oversupply relative to other size fractions. The sand/gravel was observed to compose a fair percentage of the mobile stream bed in addition to collecting in pools and velocity shadows. The coarser sediment component of the bed was also observed to be sub-angular, lending itself somewhat more to packing and requiring more stream energy for bed mobilization.

Field observations were conducted following a snow melt runoff event of 6 years or greater recurrence. When snow melt flows are contained within the banks (less than 1 year recurrence), sediment is scoured from the riffles and deposited in downstream pools. As flows approach or exceed bankfull, sediment is scoured from pools and redeposited in downstream riffles (Keller, 1971; Lisle, 1979). Subsequent lower flows will again move sediment from riffles to pools. In this manner, sediment that would have moved rapidly from the upland areas during last year's high snow melt runoff, could be conveyed and transported through the lower-gradient fish-bearing reaches. The unsorted sediment conditions observed may be the effect of transport of the pulse of sediment resulting from high flows. Alternatively, last year's high flows may imply that increased flushing flows are not likely to significantly affect the armoring problem

Few of the confined segments within the WAU are tightly confined within valley walls. Most have at least an additional channel width of floodplain along one or both banks. During high flow events, these small floodplains provide vegetated overflow areas that dissipate stream energy, reduce flood depths, and reduce scour in the main channel. Few channels within the WAU have defined alluvial rather than glacial terraces, indicating a rather stable post-glacial regime.

Debris flow does not appear to be an active process in this basin based on photo and field evidence, although dam break evidence was found in the steeper, confined mainstem segment 5.

Dam break associated with beaver dam failure was observed in segments 4 and 509 and in segment 7 where breaching is moderated by a wider floodplain.

Approximately 65 percent of the mapped channels within the WAU are ephemereal or intermittent. Glacial lag boulders eroded from the glacial soils provide the main roughness element in many of the observed intermittent and ephemeral channels. Forest canopy litter was also observed to function in these small channels along with roots of standing trees.

Grassy swales with no defined channel were removed from the stream layer. All or portions of these swales may in fact be wet during certain times of the year; however, surface runoff conditions are not sufficient for channel initiation. Segment 203 has a well-traveled road located within a former wet swale. The result has been a displacement of the absorption and filtering function of the swale. Former subsurface flow is now channelized into the road ditch, and both the road surface and the ditch drain directly into a stream channel. A high potential exists for increasing the sediment-contributing drainage area in this manner due to the number of non-surface draining swales within the WAU. Forest harvest activities have a high potential to contribute to this situation than other land uses due to the intensity of ground-based operations within areas of swale topography.

The distribution of land use within Onion Creek concentrates the commercial forestry activities within the headwater areas and the non-forestry activities within the valleys where the majority of fish-bearing streams are located. Out of approximately 46 miles of known fish and potential fish-bearing streams within the WAU, 33 miles (72 percent) flow through non-forest or small landownership (see Figure 2, Ownership Map).

Confidence in assessing current channel conditions within the fish-bearing mainstem and mainstem tributary channels is high due to the amount of field surveys and reconnaissance conducted. The emergency water typing rule invoked following the field work introduced uncertainty in extending the current Type 3 waters.

3.0 FISH HABITAT ANALYSIS

The fish habitat assessment for the Onion Creek Watershed used current and historical information to 1) identify fish species present in the watershed, 2) summarize the status of fish populations and fisheries management plans, 3) identify typical habitats and habitats of special concern, 4) discuss habitat conditions, and, 5) summarize vulnerability of various habitat types to changes in conditions that may be a result of forest practices.

This analysis consisted primarily of compiling and summarizing results of fish and habitat surveys completed in the watershed. Interviews were conducted with regional fisheries biologists familiar with the watershed fisheries. Field work consisted of visiting representative reaches throughout the watershed to verify results of previous survey work.

3.1 Fish Distribution and Population Trends

3.1.1 Available Information

Only two fish surveys have been conducted in the Onion Creek Watershed. In 1988, Washington Department of Fish and Wildlife conducted electro-shocking surveys in a reach below highway 21 and another reach above the falls (west half Sec 1, T38 R38). The reach below the falls was sampled in a joint project between Washington Department of Fish and Wildlife and the Colville Tribe in September 1991. All fish species sampled during these surveys are summarized in Table E/F-2. The fish collected at both sites in the WDFW survey were generally small, ranging in size from 3.0 to 9.7 inches, with a mean length of 6.3 inches. Brook trout are not native.

Stocking records were requested from Washington Department of Fish and Wildlife. There were no records prior to 1982 available. There are no records of any fish stocking occurring in the Onion Creek watershed between 1982 to the present. The presence of brook trout in the watershed indicates that stocking either by WDF or private parties has occurred sometime prior to 1982.

Table E/F-2. Fish sampled in 1988 & 1991 fish surveys conducted by Washington Department of Fish and Wildlife and the Colville Confederated Tribes.

Species sampled	1988 Numbers	1991 Numbers
below highway 21		
Kokanee, Oncorhynchus nerka		2*
Rainbow Trout, *Oncorhynchus gairdneri*	58	250*
Cutthroat Trout, *Salmo clarki*		?*
Brook Trout, *Salvelinus fontinalis*		2*
Bull Trout, *Salvelinus malma*		2*
Bluegill, *Lepomis macrochirus*	4	
Dace, *Rhinichthys spp.*	7	
Sculpins, *Cottus spp.*	4	
Northern Squawfish, *Ptychocheilus oregonensis*	2	
above Falls		
Rainbow Trout, *Oncorhynchus gairdneri*	38	
Brook Trout, *Salvelinus fontinalis*	4	

* there are data sheets missing from this survey, records of some species are based on conversations with R.LeCaire who was on the survey crew.

3.2 Distribution and Life History Requirements

This fisheries assessment focuses on instream habitat conditions influencing the growth and survival of kokanee salmon, brook trout, and rainbow trout. Other stream dwelling fish species are not addressed in this report. A waterfall approximately 100 feet tall is 1.2 miles upstream of the mouth of Onion Creek. This falls functions as a permanent barrier to fish passage in the watershed. The life history requirements of salmonids in the Onion Creek Watershed are summarized in Table E/F-3.

Table E/F-3: Simplified description of habitat preferences of key fish species found in the Onion Creek Watershed (Compiled from Behnke, 1992; McPhail and Murray, 1979; Meehan and others, 1992; Shepard et al., 1984; Wydoski & Whitney, 1979).

Species	Life History	Habitat Preferences	Timing
Rainbow	Spawning	0.2 - 1.6" gravel, redd sizes < 2 ft²	April - May
	Incubation	No redd scouring or siltation	temp dependent, spring/summer
	Winter habitat	Pools, interstitial spaces in cobble/ gravel substrate	water temps. <4 °C
	Summer habitat	water temps. 13-21° C, food and escape cover (lethal temps. 26° C)	
Cutthroat Trout	Spawning	0.2-3.2" gravel, redd sizes 1-2 ft²	Jan. - April
	Incubation	Stable clean substrate, usu. 50 - 100 days	temp. dependent
	Winter habitat	Pools, interstitial spaces in cobble/ gravel substrate	Water temps < 5°C
	Summer habitat	Pools & lateral habitats, food & escape cover (temps 10 -19° C, lethal 22.8° C)	Water temperatures > 5°C
Brook Trout	Spawning	0.1 - 1.6" gravel, redd sizes < 2 ft²	late Sept. - Nov.
	Incubation	No redd scouring or siltation	Winter
	Winter habitat	Pools, interstitial spaces in cobble/ gravel substrate	water temps. < 4 °C
	Summer habitat	water temps. 10-19° C, food and escape cover (lethal temps. 25.3° C)	
Bull Trout	Spawning	loose gravels and cobble	primarily Sept.& Oct.
	Incubation	success increases with temperatures <10°C, optimum 2 to 4°C, stable substrate	September - April
	Winter habitat	Pools, interstitial spaces in cobble/ gravel substrate	Water temperatures < 5°C
	Summer habitat	temps 9 - 15° C, food and escape cover	Water temperatures > 5°C

Map E-1/F-1 illustrates the distribution of salmonid species occurring in the WAU. Additional maps illustrating zones of dominant species use or areas of special habitat concern (ie. summer rearing, winter rearing, spawning) were not produced for this analysis because species utilizing the watershed above the falls, rainbow trout and brook trout, utilize the entire stream network during all life history stages and do not typically segregate into specific areas. Below the falls, adfluvial kokanee and bull trout have been recorded. These fish potentially utilize the entire lower reach for spawning and this area is identified on Map E-1/F-1.

On November 14, 1996, the Forest Practices Board adopted an emergency rule that redefines the physical parameters used to describe Type 3 waters. The new typing system is based on width, gradient and drainage area as follows: 1) Streams at least 3 feet wide and up to 16% gradient, or 2) Streams greater than 16% gradient draining an area of at least 175 acres. Any streams meeting these criteria are presumed to have fish and receive riparian protection unless fish absence is proven. Potential fish bearing reaches as defined by this new rule are also designated on Map E-1/F-1.

The Onion Creek WAU contains several small drainages which flow directly toward the Columbia River. Most of the drainages are ephemeral with low flows and no surface connections to the Columbia. Five Mile Creek, north of Onion Creek does have perennial flow. The outlet of this stream was visited during the field reconnaissance, and a very steep reach just below the highway appears to be a fish passage barrier. No additional habitat surveys were done in these segments.

3.2.1 Resident Native Fish Distribution

This portion of the Columbia River system was covered in ice during the last (Fraser) glaciation, and the current native fish faunas were attained through post-glacial dispersal from the main Columbia system (McPhail and Lindsey, 1986). The distribution pattern of bull trout is largely the result of headwater migrations and drainage crossover by stream capture following the retreat of the last continental ice sheet (Cavender, 1978). This suggests that bull trout and other native salmonids are species that survived glaciation only within refugia (Haas and McPhail, 1991). There are no portions of Onion Creek which are likely to have provided refuge during the glaciation and the presence of the falls near the mouth of Onion Creek would have prevented any fish from dispersing into the upper portion of Onion Creek from below. It is likely that Onion Creek did not support a native fish population, and that the rainbow trout (the only species observed which may have been a native) have been stocked.

3.2.2 Kokanee

Kokanee are landlocked sockeye salmon which occur in Lake Roosevelt. These fish are thought to have descended from a formerly anadromous population of Columbia River sockeye salmon (Groot and Margolis, 1991). Adults will migrate from Lake Roosevelt into stream reaches in the fall to spawn in tail out gravels of deep pools. After incubation the fry migrate into Lake Roosevelt to rear. Two kokanee were observed in the 1991 fish surveys. A trap was installed by the Colville Confederated Tribes in 1996 at the Highway 21 crossing to monitor kokanee and bull trout utilization of the lower reach. No fish were captured. Residents along the lower stream reach historically observed significant numbers of "red fish," which were probably kokanee or sockeye spawning in the lower reach of Onion Creek. Presence of kokanee in spawning condition was confirmed in 1991 (R. LeCaire, CCT, pers. comm., 1996). Kokanee populations in Lake Roosevelt have decreased in recent years. This decrease may be related to several factors. Sport fishing for kokanee has increased significantly and over-fishing may be depleting stocks. In addition, water operations have decreased water levels during the egg incubation period which would dry out redds and result in decreased spawning success (R. LeCaire, CCT, pers. comm., 1996).

3.2.3 Rainbow Trout

An adfluvial population of rainbow trout is present in Lake Roosevelt which may be a remnant of the formerly anadromous steelhead population (Groot and Margolis, 1991). Adults enter tributary streams in the winter and spawning occurs in April and May. Juveniles may rear in streams for some months, although high flow events may flush rainbow fry into the lake. Rainbow trout have been collected in lower Onion Creek in samples collected by WDFW and the Colville Confederated Tribes. Fish which were collected were small, ranging in size from 3 to 9 inches. It is uncertain if these were resident or rearing adfluvial fish.

Resident rainbow trout occurring above the falls would also spawn in the early spring. Eggs will incubate during the high flow periods. Summer rearing habitat can be varied although rainbow trout will usually be associated with cover of some type. During the winter, cold temperatures keep fish relatively immobile. They prefer deep pools or areas with access to interstitial substrate spaces.

3.2.4 Cutthroat Trout

Cutthroat trout are resident in Lake Roosevelt and were observed in lower Onion Creek during the 1991 fish surveys. There are no records of cutthroat trout occurring above the falls, although small remnant populations may exist in headwater areas.

3.2.5 Bull Trout

Bull trout (*Salvelinus confluentus)* has been identified by Cavander (1978) as a distinct species of char unique to western North America. They are currently considered a Federal Category I (C1) species currently under consideration for listing by the U.S. Fish and Wildlife Service as a threatened or endangered species. The Service concluded that sufficient information on the biological vulnerability and threats to the species was available to support a warranted, but precluded, finding to list bull trout. This decision will be reviewed in June 1996.

Bull trout exhibit both resident and migratory life history forms (Rieman and McIntyre 1993). The presence of the waterfall in lower Onion Creek prevents any fish migrations. Bull trout which have been collected in lower Onion Creek are probably part of a fluvial population present in low densities in Lake Roosevelt. There are no records of bull trout occurring in the upper portion of the Onion Creek Watershed.

3.2.6 Eastern Brook Trout

Brook trout were observed throughout the Onion Creek drainage. Their habitat requirements for summer and winter rearing are similar to rainbow trout, although brook trout tolerate a wider range of conditions. Because they are tolerant of more diverse spawning and rearing habitat conditions, brook trout typically displace the native fish which may occur in a drainage.

3.3 Summary of Habitat Conditions

3.3.1 Field Surveys

Approximately 0.75 miles of stream were surveyed with data collected on all key habitat parameters for this analysis. Numerous spot checks and reconnaissance surveys were also conducted. The riparian analyst provided LWD counts from additional segments. Channel attributes from the surveys are summarized by segment in Form E-5 found at the end of this report along with sample field data collection forms.

3.3.2 Determination of Habitat Diagnostics

The Watershed Analysis Manual requires that comparisons be made between the existing conditions and a table of indices of resource condition which have been developed in the manual. This list of reference conditions was developed for habitat conditions in western Cascade streams and is not well suited for streams in the northeast portion of Washington. More appropriate indices of habitat condition were developed for this analysis. Selected habitat variables from habitat suitability index (HSI) models for brook trout, cutthroat trout, and rainbow trout were used as references (Raleigh, 1982; Hickman and Raleigh, 1982; and Raleigh et al., 1984). The habitat suitability curves were identical for all three species so only one set of parameters is developed for this analysis. Habitat variables from these models were matched with habitat parameters measured in the field. Habitat quality rankings were developed from the suitability curves (Table F-4).

Indices for LWD in the Watershed analysis manual were developed from information on streams in western Washington. To address conditions in eastern Washington streams several data sources were utilized. Montgomery et al. (1995) found LWD exerted a systematic influence on pool spacing in pool-riffle, forced pool-riffle, and plane bed morphologies. LWD also apparently decreases pool spacing (channel widths/pool) in step-pool channels. They found an inverse relationship between pool spacing and LWD frequency (pieces/m). Pool spacing declined significantly with increases in LWD frequency from 0 to 0.2 pieces/m, declined gradually with increases from 0.2 to 0.5 pieces/m, and declined very little with increases above 0.5 pieces/m.

Table E/F-4. Indices of resource conditions

	Habitat Quality Ranking		
Habitat Parameter (source)	**Poor**	**Fair**	**Good**
Percentage pool area (Raleigh et al. 1984)	<20% or > 70%	20 -30 %	30-70%
Pool depth & Cover Class (Based on Raleigh et al. 1984)	> 30 %, < 15cm deep and <30% LWD formed	> 30 %, >15cm deep and ≥30% LWD formed	> 60 %, > 60 cm deep and >60% LWD formed
Substrate (Washington Manual)	Sand or small gravel is sub-dominant in boulder or cobble dominant units (ie. Interstices filled)	Sand is sub-dominant in some units with cobble or boulder dominant (interstices reduced)	Sand or small gravel is rarely sub-dominant in any unit (interstices clear)
Gravel Availability (Washington Manual)	absent or infrequent		Frequent spawnable areas
LWD (Overton et al.1995, Martin 1996)	<0.2 pieces/cw	0.2-0.4 pieces/cw	>0.4 pieces/cw

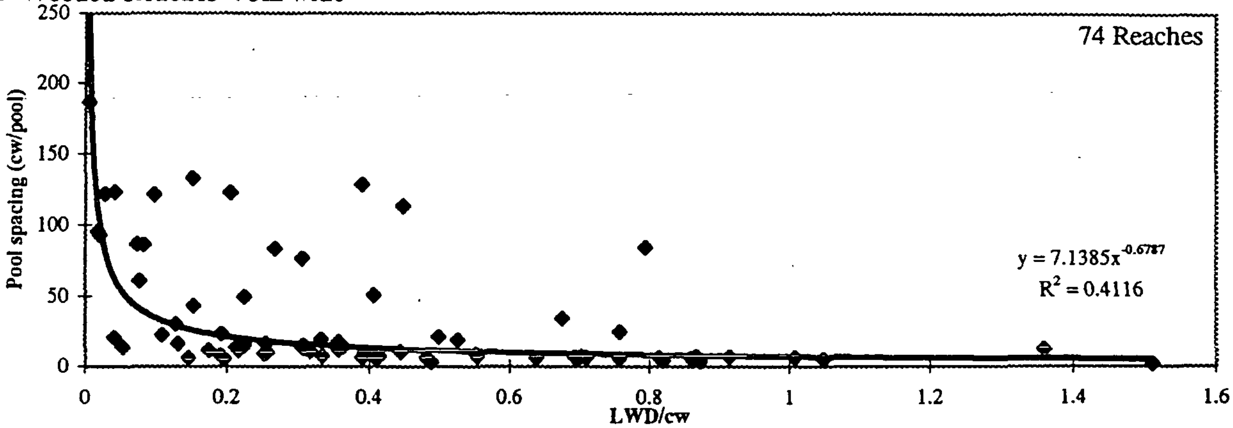
In the West Branch Watershed Analysis, Martin (1995) used data collected within the WAU to develop a watershed specific relationship between LWD and pool spacing. The criteria developed for West Branch WAU are as follows; Poor <0.2 pieces/cw, Fair 0.2-0.6 pieces/cw, and Good >0.6 pieces/cw. We did not sample enough stream reaches to develop a relationship specific to the Onion Creek Watershed. In order to test this relationship we took the Natural Conditions Database compiled by Intermountain Research Station (Overton et al., 1995) and plotted the relationship between LWD/cw (wetted) and pool spacing (wetted cw/pool). This database contains information from 196 stream reaches which occur in wilderness areas or areas which have not been subjected to extensive management activities, and therefore represents 'pristine' or undisturbed stream habitat conditions. This data was collected in the Salmon River Basin in central Idaho. The climatic, hydrologic, and geologic conditions in this area relatively similar to those in northeastern Washington. This analysis only included stream reaches which passed through forested areas and contained large woody debris. Since channel width strongly influences pool spacing in forest streams (Montgomery et. al., 1995), we plotted the relationship between LWD and pools based on wetted channel widths (Figure E-1b-1d).

The plots in Figure E/F-1a clearly illustrate an inverse relationship between LWD and pool spacing in streams less than 5 m wide. As the number of pieces of LWD increase, the space between pools decreases. There is no clear relationship in stream channels greater than 5 m. For stream channels less than 5 m wide, the greatest decrease in pool spacing is observed between 0 and 0.2 pieces of LWD per channel width. Between 0.2 to 0.4 pieces of LWD per channel width, some decrease in pool spacing is apparent, and the decreases level out with greater than 0.4 pieces of LWD per channel width.

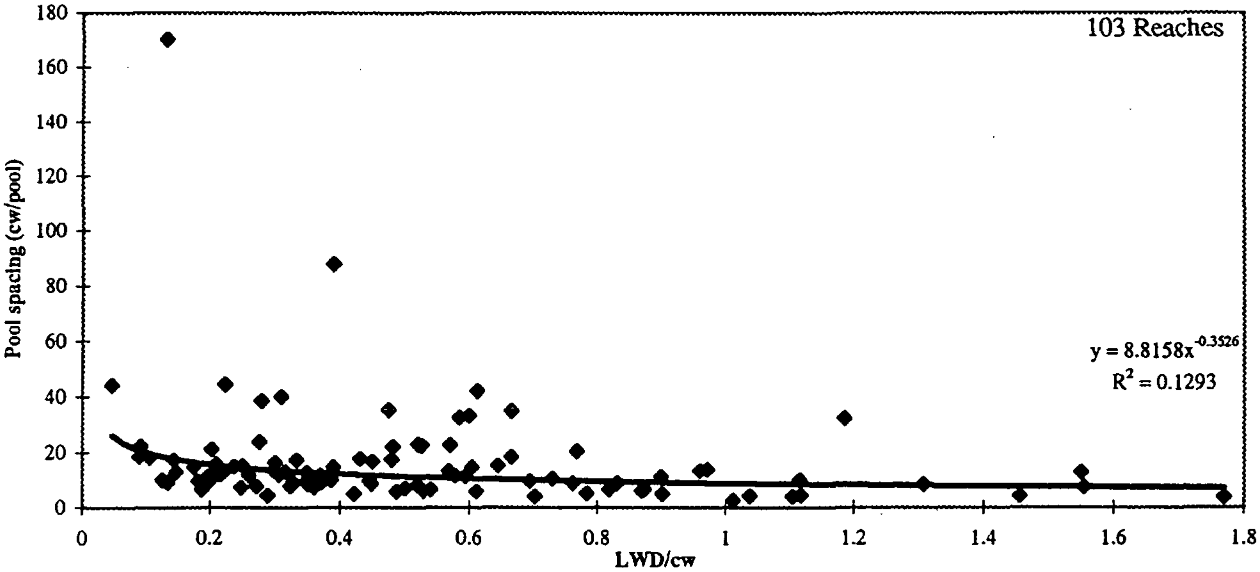
To further test this relationship, we plotted the data from streams less than 5 m wide by gradient and confinement classes (Rosgen designation) (Figures E/F 2a, b, c). These plots illustrate LWD has less influence on pool formation in higher gradient, confined streams and has a stronger influence on lower gradient, less confined streams.

Figure E/F-1: Relationship of LWD to pool spacing by stream size. Mainstem stream segments passing through forested areas containing lwd and pools (Natural Conditions database Overton et al. 1994).

A- Wooded Reaches < 5m wide



B- Wooded Reaches >5m and < 10m wide



C- Wooded Reaches >10m wide

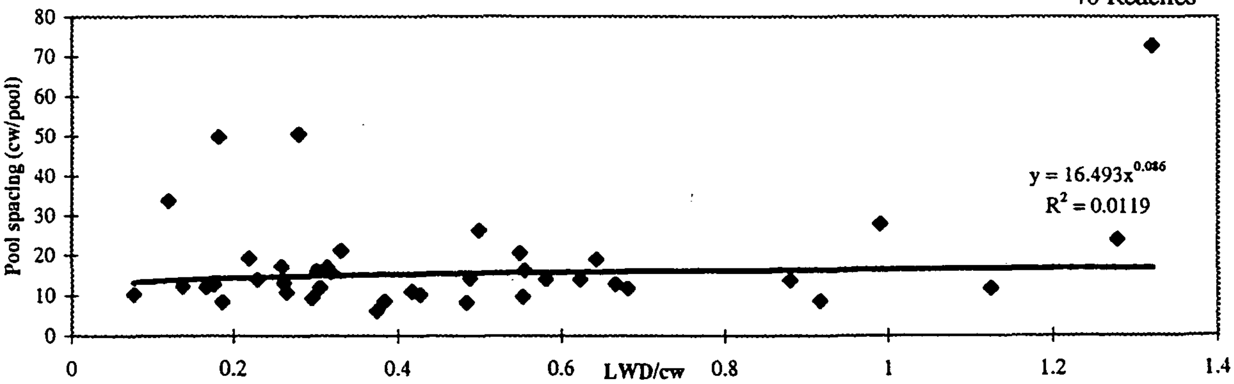
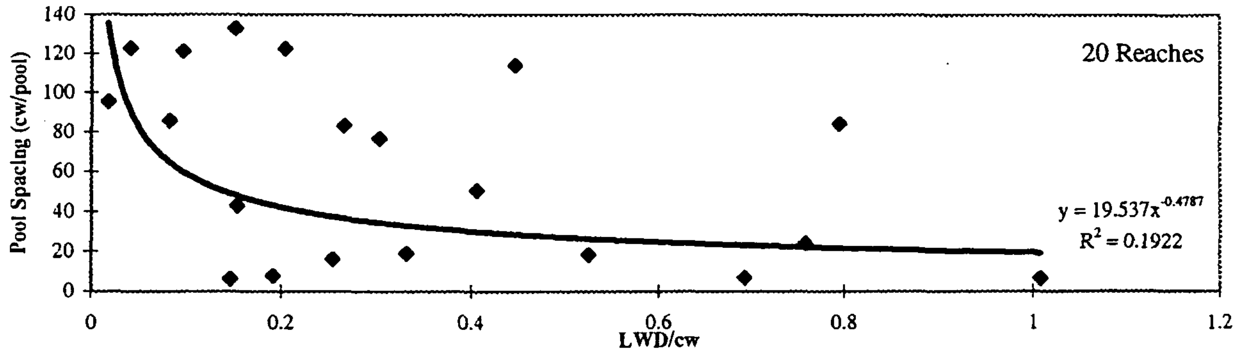
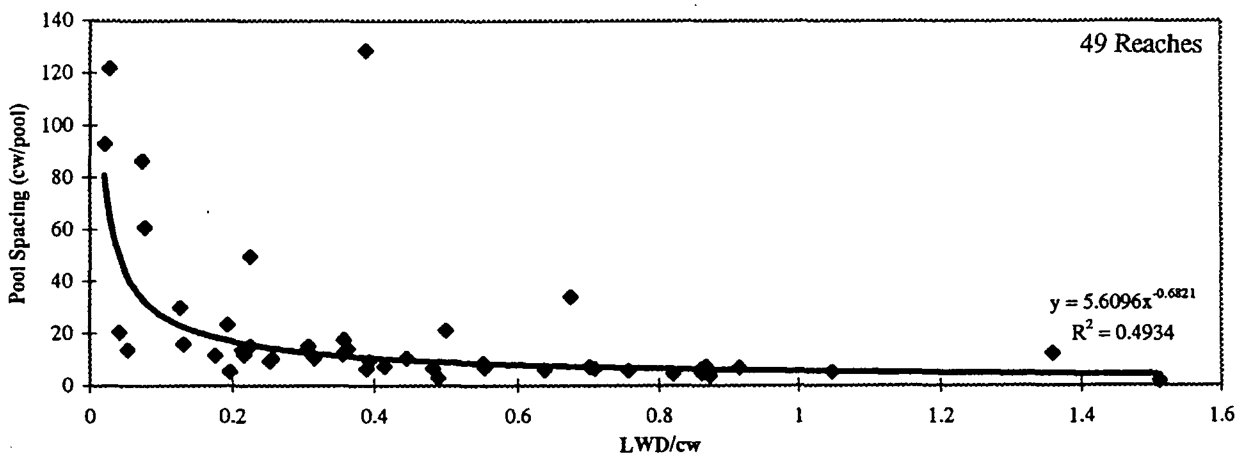


Figure E/F-2: Relationship of LWD to pool spacing by gradient and confinement classes (Rosgen Type). Mainstem stream segments passing through forested areas containing lwd and pools (Natural Conditions database Overton et al. 1994).

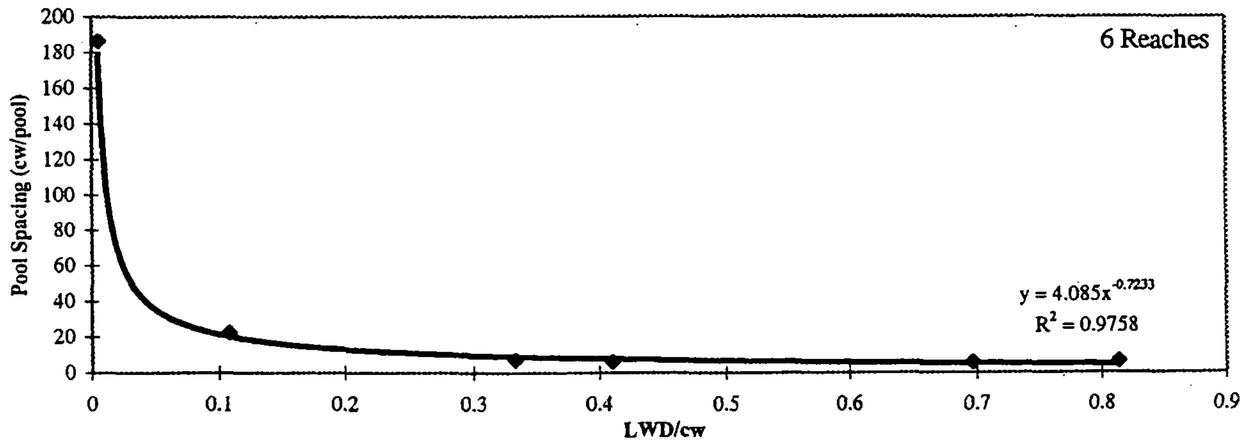
A- Wooded Reaches < 5m wide (Rosgen A, gradient 4-10%, confined)



B- Wooded Reaches < 5m wide (Rosgen B, gradient 2-4%, moderatly confined)



C- Wooded Reaches < 5m wide (Rosgen C, gradient <2%, unconfined)



Martin (1995) developed a similar relationship working with data from the West Branch Watershed with 13 data points. The LWD criteria developed for West Branch WAU were: Poor <0.2 pieces/cw, Fair 0.2-0.6 pieces/cw, and Good >0.6 pieces/cw. From the Natural Conditions Database, the criteria from West Branch appear conservative for streams less than 5 m wide but would be appropriate for streams between 5 and 10 m wide. Since the relationship developed from the Natural Conditions Database have a larger sample size and all streams in Onion Creek were less than 5 m wide, we applied the following criteria for our analysis: Poor <0.2 pieces/cw, Fair 0.2-0.4 pieces/cw, and Good >0.4 pieces/cw.

3.3.3 Habitat Condition Evaluation

Habitat conditions which were quantitatively sampled during the field visit are summarized in Form E-5 in the appendix of this section. The habitat diagnostics determined for key habitat parameters are summarized in Table E/F-5 (Form F-3).

3.4 Areas of Habitat Concern

Habitat conditions in the Onion Creek Watershed were variable. Following is a general discussion of key observations and concerns identified in the watershed.

3.4.1 Spawning Gravel \ Winter Rearing Habitat

The presence of fine sediment (particles < 0.6 cm) mixed with gravels, cobbles and boulders severely reduces the availability of winter rearing habitat by filling interstitial spaces which would be utilized as refuge. The mix of particle sizes reduces the quality of spawning habitat. Fish observed and sampled in the watershed were generally small and would be expected to spawn in smaller gravels (<1"). However, the observed mix of large and small particles reduces the ability of small fish to excavate redds.

The area of pool habitat and number of pools was good for almost all reaches sampled. However pools were not as deep as would be expected for optimal habitat.

3.4.2 Large Woody Debris

LWD numbers were generally fair to good. The distribution and function of LWD in segments 4, 5, 7, and 509 was influenced by previous beaver activity based on the presence of old beaver dams. In these reaches 'old' wood is being eroded out of stream banks indicating there has been a long history of beaver activity.

LWD appears to play a critical role in maintaining habitat conditions in the steeper tributary reaches. Segment 505 provides a graphic example of the function of LWD. Habitat conditions above a channel failure due to a pipe burst consist of deep step pools formed primarily by the interaction of LWD and boulders. Below the failure, limited LWD is present and has not become fixed in the channel. This segment is a boulder cascade with few pools and a shallow channel.

Table E/F-5 (Form F-3): Onion Creek Habitat Condition Evaluation.

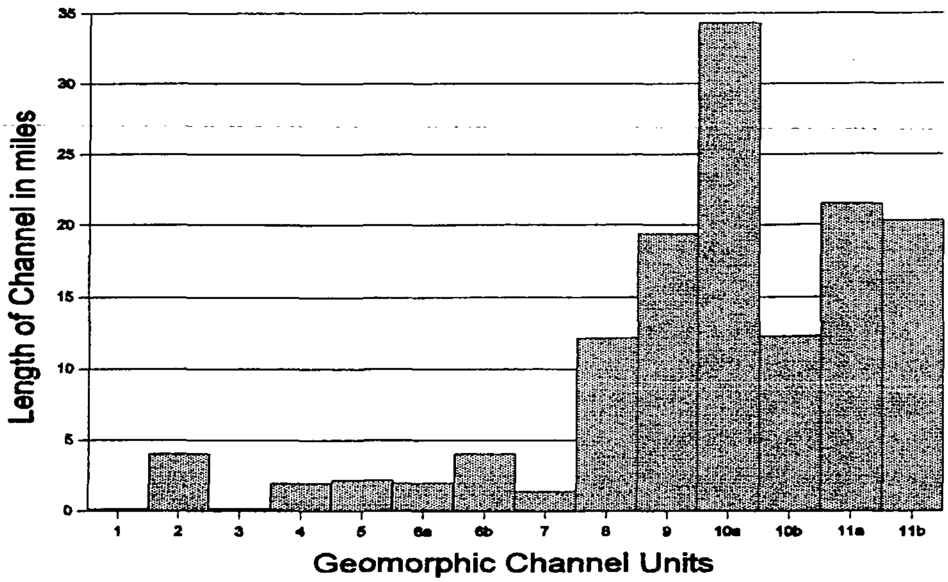
Segment Number (distance sampled)	% Pool Area	Pool depth (% pools > 15 cm / %> 60 cm) & Cover Class (% pools LWD formed)	Substrate (Winter Rearing)	Spawning Gravel Availability	LWD
1 (700 ft)	na[1]	na[1]	no spaces **Poor**	none **Poor**	0 **Poor**
2 - below hwy (730 ft)	21% **Fair**	89%>15cm/11%>60cm &~20%lwd(tree)formed (only 2 pools) **Poor**	no spaces **Poor**	very few patches **Poor**	.16 **Fair/ Poor**
2 - above hwy (415 ft)	11% **Poor**	100%>15cm&50%lwd formed (tree scour) **Fair/ Poor**	no spaces **Poor**	none **Poor**	0 **Poor**
3 (~200 ft)	?	?	spaces filled **Poor**	none **Poor**	low-none **Poor**
4 - above falls to beaver dam (590 ft)	52% **Good**	100%>15cm&53%lwd formed **Fair/Good**[3]	no spaces **Poor**	spawninggravels mixed with fines **Poor**	.99 **Good**
4 - open area above falls (170 ft)	15% **Fair**[2]	one pool in reach **Poor**	no spaces **Poor**	spawninggravels mixed with fines and cobbles **Poor**	1.5 **Good**
4 - above county road (408 ft - split channel 205 ft)	15% **Poor**	100%>15cm&~50%lwd formed **Fair**	no spaces **Poor**	spawninggravels mixed with fines and cobbles **Poor**	.84 **Good**
7 - lower (375 ft)	67% **Good**	82%>15cm/18%>60cm & 63% lwd formed **Fair**	no spaces **Poor**	patches of gravel in 3 of 15 units **Fair/Poor**	.74 **Good**
7 - mid with cattle (340 ft)	68% **Good**	100%>15cm&50%lwd formed **Fair**	no spaces **Poor**	one small patch of gravel **Poor**	.97 **Good**
305 (250 ft)					.14 **Poor**
501 (100 ft)					.02 **Poor**
502 (upper) (256 ft)	34% **Good**	100%>15cm&37%lwd formed **Fair**	spaces reduced **Fair**	small patches of gravel **Poor/Fair**	.79 **Good**
509 (600 ft)	?	100%>15cm&~40%lwd formed **Fair**	no spaces **Poor**	coarse sand near margins **Fair**	.13 **Poor**
601 (150 ft)					.37 **Fair**
602 (300 ft)	50% **Good**				1.3 **Good**
701- upper road x-ing (200 ft)					.23 **Fair**
705 (100 ft)					.90 **Good**

1 - Segment is within Lake Roosevelt influence

1- Segment pool area was 15%, with 35% glide

2- Segment exceeds criteria for wood formed pools but does not quite meet criteria for depths

Figure E/F-2. Lengths of stream by geomorphic channel unit.



1. Mouth of Onion Creek (<1%)

Description: This morphologic unit describes a single unique segment of the lower mainstem Onion Creek that is influenced by the raising and lowering of Lake Roosevelt. The gradient is less than 1 percent, and the dominant substrate is coarse sand. When the lake level is down, the bed morphology tends to long glides with occasional bank or bedformed, shallow pools. The channel has some terrace confinement of the left bank, but is generally unconfined. Sediment deposition patterns and particle sizes fluctuate with the changing daily and seasonal lake levels. As the lake level rises, the deposition of finer material occurs farther upstream. An observed medial bar was composed of a layer of gravel on the bottom, coarse sand in the middle and organic silt on the top. From tracks on the sand bars, this reach appears to be frequently utilized by the local wildlife.

Habitat Conditions: The habitat in this unit is influenced by variable lake levels and sediment deposition. The frequency of this variation is unknown. Habitat conditions are not stable for the duration of the spawning, egg incubation, and winter rearing periods (September to May). Therefore, the only function of this unit is as a migratory corridor to more stable reaches upstream.

Segments: *Field verified*: 1

<u>Conditions and Response Potential</u>:

Coarse Sediment: Both coarse and fine sediment deposit in this delta segment of the Columbia River. The coarser sediment is deposited further down the segment during higher stream flows and lower Columbia River flood conditions. Both gravel and sand bars develop. An increase in coarse sediment would temporarily increase the channel width and decrease the depth, which may temporarily block fish migration access to Onion Creek. Following deposition, the channel would reincise within the deposit. No distributary or braided channel pattern common to high sediment load deltas were noted in this segment. The location of this segment within the older delta/fan complex did not change between the earliest photos and the present. This could indicate a moderate coarse sediment load or that a high component of sediment load is mobile or suspendable through to the Columbia. *High sensitivity/vulnerability*

Fine Sediment: Due to the flucuating flood conditions, fine sediment may easily bury or fill the coarser gravels in areas where spawning has occurred or those areas that may have provided spawning opportunties for adfluvial species. *High sensitivity/vulnerability*

Peak Flow: The segment is directly influenced by the flucuating level of Lake Roosevelt, which may flood the segment during peak flow events and during periods of water storage. Overbank inundation of the immediate floodplain provides a low energy, backwater environment rather than the scour potential of concern in this rating. *Low sensitivity/vulnerability*

Large Woody Debris: Due to the periodic flooding in this unit, wood would not function to modify channel characteristics. Wet site conditions do not support tree growth. *Low sensitivity/ vulnerability*

Riparian Vegetation: The roots of wetland grasses and other vegetation provide the structure against erosion of the fine-textured streambank soils and help to limit the extent of channel widening. Little additional fish habitat is gained, however, as grass roots did not appear to promote bank undercutting here, the channel lacked cover and is too shallow to provide anything but a migration corridor during flood conditions. *High sensitivity*

Dam breaks: No dam break potential exists within this segment due to the extremely low gradient. This segment is buffered from the direct impact of upstream dam break by long lengths of low gradient segment 2 channel, which is currently very low in dam-forming wood. *Low sensitivity/vulnerability*

2. Mainstem , 1-2%, moderately confined to unconfined

<u>Description</u>: Unit 2 includes the lower-gradient channels of the mainstem of Onion Creek. These segments occur near the mouth of Onion Creek in an alluvial fan-terrace complex (segment

2), in the upper middle part of the watershed within a glacial outwash deposit (segment 7), and within a low-gradient reach of deep till soils (segment 10). The bed morphology is dominated by pools and riffles forced by wood and banks. The channels are moderately confined to unconfined within gentle valley slopes and terraces. Portions of segment 2 have been artificially incised and confined. A plane bed almost devoid of pools persists in segment 2 where channel straightening has occurred above and below the highway concrete box culvert and within an agricultural area apparently straightened to promote drainage 30+ years ago by the local conservation district. Cabled logs line both banks of the channel for approximately 2,500 feet upstream of the highway. The bed surface in the unchannelized section is composed of fine to coarse gravel, and large gravel and small cobbles dominate in the channelized portions of segment 2. Channel gradients are approximately 1 percent, but may be as high as 2 percent within the channelized area. Evidence of past beaver activity was found in segment 7 below an area maintained as cattle pasture. One channel-spanning impoundment, apparently for stock watering, was noted in segment 7. Livestock were also observed to have access to segment 10. Low flow discharge in segment 10 was measured at 1.4 cfs.

Habitat Conditions: The channelized portion of segment 2 has a uniform, shallow glide and riffle composition with virtually no pools or LWD to provide cover or refuge. This morphology is very poor fish habitat. The unchannelized segments currently sustained good to fair habitat conditions. Bank vegetation in segments 2 and 7 were generally dense grasses and shrubs providing cover, undercut banks, and leaf litter inputs. Pools were frequent and moderately deep. Suitable patches of spawning gravels for adfluvial fish (0.1 to 3.0 inches) were present in only small areas. Larger substrate particles were 40 to 50 percent embedded resulting in few interstitial spaces for winter refuge and rearing. LWD functions to form pools and cover and is lacking in segment 2.

Segments:	*Field verified:*	2, 7
	Reconnaissance:	10

Conditions and Response Potential:

Coarse Sediment: The Onion Creek sediment load is high in fine gravel/very coarse sand-size particles eroded from extensive glacial till deposits within the watershed. These particles constitute both the coarse fraction of the bed and deposit in pockets, velocity shelters, and overbanks as fines. Increases in coarse sediment, and this particle size in particular, have and will deposit on the bed, fill pools, and may overwhelm some wood structures. Coarse sediment deposited in an area of segment 10 was observed to cause multiple, shallow channels providing little habitat complexity. The fine gravels could provide good spawning habitat for resident fish; however, they were generally unsorted due in part to the high volume of fine gravel within the system. *High sensitivity/vulnerability*

Fine Sediment: As discussed above, gravels in this unit lacked sorting appropriate for good spawning. Increases in fines will contribute to this condition and fill interstial spaces of sorted gravels. Pool filling by fines within the sampled segments was as high as 30 percent in segment 7 with access to cattle and very low in segment 2 below the highway. Pool filling increases with a higher sediment input, such as that available within the eroded cattle area, and with an increase in the number of pools. *High sensitivity/vulnerability*

Peak Flow: Peak flows are accommodated within the vegetated flood plain adjacent to most reaches. Some increase in bank erosion and rearrangement of woody debris would be expected with increases in peak flows. With adequate LWD and riparian root strength on the banks, impacts from peak flows would be moderate. *Moderate sensitivity/vulnerability*

Large Woody Debris: Lower pool surface area corresponds with lower wood counts in the survey data between segments 2 and 7 (see Form E-5). In the absence of wood, deep pools formed at the banks in segment 2 below the channelized reach. Plane bed morphology is dominant within the portion of segment 7 recovering from agricultural grazing. This channel did not have much sinuosity which could promote bank-formed pools without wood. LWD within segment 7 where cattle are grazed is old and decaying with little recruitment potential. *High sensitivity/vulnerability*

Riparian Vegetation: Tree roots are the observed primary sources of bank protection in unit 2 streams but is also supplied by LWD, wood buried in the banks, and less effectively by grass roots. Stream banks along the channelized portion of segment 2 are protected by cabled logs. A higher percentage of bank erosion occurs within unit 2 channels where livestock were observed to have access to the channels (segments 7 and 10) resulting in increased sediment supply, reduced wood recruitment, and reduced cover for fish. *High sensitivity/vulnerability*

Dam breaks: Dam break could occur within these channels from the breaching of beaver dams or impoundments. Due to low gradients and vegetated floodplains, the resulting flood wave would attenuate quickly. Localized bank erosion and channel rearrangement could result. *Moderate sensitivity/vulnerability*

3. Bedrock Falls (>20 %)

<u>Description</u>: This unit applies to segment 3, a bedrock falls located at the intersection of the uplands and the Columbia River terrace. The falls are carved from metalimestone and are precipitious, dropping near vertically for approximately 80 feet. Total drop over the 500 foot segment is approximately 160 feet, or an average gradient of 32 percent (measured from topographic map). The segment includes a lower gradient area at the base of the falls transitional to the segment below. A dam and old pump house located at the head of the falls allows very little transition in gradient between segment 4 above and the falls.

<u>Habitat Conditions</u>: This steep segment is a fish barrier and doesn't offer any habitat.

<u>Segments</u>: *Field verified*: 3

Conditions and Response Potential:

Coarse Sediment: All coarse sediment is transported through this segment, or held for a short time in pockets among the bedrock and boulders. *Low sensitivity/vulnerability*

Fine Sediment: Fine sediment is transported through this segment. *Low sensitivity/vulnerability*

Peak Flow: The bedrock banks and extremely steep gradient in this segment are essentially invulnerable to changes in peak flows. *Low sensitivity/vulnerability*

Large Woody Debris: Wood was not observed to be functioning in this segment. Recruitment immediately above the steep gorge is limited to wind throw and mortality, and breakage is likely to occur as trees drop into the steep, narrow bedrock channel. *Low sensitivity/vulnerability*

Dam breaks: Dams are unlikely to form or persist in this segment, and the steep gradient extremely limits ponding volume potential. *Low sensitivity/vulnerabiltiy*

Riparian Vegetation: Banks are bedrock. *Low sensitivity/vulnerability*

4. Mainstem, 2-4%, moderate to confined within terraces and sideslopes

Description: Mainstem segments 4 and 6 are included in this unit. Segment 4, located immediately upstream of the falls, is moderately confined within a deposit of glaciofluvial and alluvial sediments. Segment 6 is transitional between a higher gradient, confined channel below (segment 5, unit 5) and a lower gradient segment above (segment 7, unit 2). Confinement is generally moderate within valley sideslopes. Channel gradients in segment 4 are mainly in the 2 to 3 percent range and those in segment 6 are in the 3 to 4 percent range. Bed morphology is forced pool-riffle in the 2 percent gradient range, increasing to as much as 50 percent step-pool in the 3 to 4 percent gradient range. Even in the 4 percent range, measured bankfull widths in segment 4 are 2 to 4 times the low flow wetted width with side channel development, attributable mainly to the storage provided by abundant riparian wood over time. In the 2 percent range, bed surface particles were visually described as bi-modal consisting of cobble-coarse gravel and abundant small gravel-very coarse sand of a granitic source. The coarser textures are dominant in the 3 to 4 percent gradient range. A large, abandoned beaver dam complex observed in segment 4. Immediately above the dams, the channel is entrenched 3 to 4 feet into dominantly silty alluvial banks. Wood previously buried within the banks is being exhumed. This entrenched portion of segment 4 has a long glide associated with it, but channel sinuosity appears to be increasing as is evidenced by higher bank erosion in this reach.

<u>Habitat Conditions</u>: The segments within this unit currently sustain good to fair habitat conditions. Bank vegetation in segment 4 is generally shrubs and forbs which provide cover and leaf litter inputs. Pools are frequent and moderately deep. Suitable patches of sorted spawning gravels for smaller resident fish (0.1 to 1.0 inches) are virtually absent due to the mix of larger cobbles with coarse sands. The larger substrate particles are 40 to 50 percent embedded resulting in few interstitial spaces for winter refuge and rearing. LWD functions to form pools and cover.

<u>Segments</u>: *Field verified:* 4
Reconnaissance: 6

<u>Conditions and Response Potential</u>:

Coarse Sediment: The Onion Creek sediment load is high in fine gravel/very coarse sand-size particles eroded from extensive glacial till deposits within the watershed. These particles are found in the bed beneath the armor layer and deposit in pockets, velocity shelters, and overbank areas. Continuing levels or increases in this particle size range will contribute to bed fining and lack of spawning gravel sorting. The reaches immediately upstream also deliver medium-size gravel, so sources for larger particles are limited to bank erosion and extremely infrequent landslides within this immediate, lower portion of the watershed. Large increases in the larger particle sizes are unlikely, but could widen the bed and bury some pool-forming structures. This rating applies to the combined effect of the low potential for a change in the current large particle-size regime and the moderate effect of continuing high levels of the fine gravel and sand. *Moderate sensitivity/vulnerability*

Fine Sediment: Inconsistent filling of pools with the fine gravel/sand material was found in segment 4 where the pool counts were higher. Sand was found in 6 out of 16 pools up to a depth of 0.4 feet. The remaining pools had little if any sand/gravel filling. This size fraction also contributes to a lack of well-sorted gravel for spawning by filling interstitial spaces. *High sensitivity/vulnerability*

Peak Flow: Measured bankfull widths are 2.3 to 3.4 times wider than low flow wetted widths indicating the systems ability to accommodate peak flows in both the horizontal and vertical directions. Bankfull over wetted width is lower in the entrenched reach above the old beaver dams, and bank erosion here is higher as sinuosity continues to develop within the entrenchment. A recent high flow event in lower segment 4 deposited silt, sand and small woody debris onto a vegetated floodplain. If wood structures are stable, then the localized scour from peak flows will promote pool formation. *Moderate sensitivity/vulnerability*

Large Woody Debris: LWD greater than 12 inches dbh was the primary pool and step former in the surveyed segments. Wood also functions to armor banks and deposit and sort gravel. Long riffles and glides develop where wood is less abundant. Overall, LWD contributes significantly to holding, spawning, and cover habitat within these channels. *High sensitivity/vulnerability*

Riparian Vegetation: With the exception of the entrenched reach above the old beaver dams, bank erosion is low and found almost exclusively at the outside of bends. The roots of large trees are the primary erosion protection followed by LWD. Grass roots were somewhat effective in the entrenched reach, and some boulders were also functioning in the upper gradient range. The buried wood in the banks above the old beaver dams also provides protection against bank erosion. *High sensitivity/vulnerability*

Dam breaks: Dam break could occur within these channels from the breaching of beaver dams or impoundments. Due to low to moderate gradients and adequate vegetated overbank area, the resulting flood wave would attenuate quickly. Localized bank erosion and channel rearrangement could result. No channel damage was noted below the failed beaver dams in segment 4; however, the features have been abandoned for several decades or more. *Moderate sensitivity/vulnerability*

5. Mainstem, 4-8%, confined

Description: This unit includes the higher gradient channels of mainstem Onion Creek. Segment 5 is confined by bedrock hillslopes. Segments 8 and 9 are confined by incised till-covered footslopes. Bed morphology is mainly step pools with some long, lower-gradient forced pool reaches associated with the longer steps. A wood jam in segment 5 measures 30 feet wide, 25 feet long, and approximately 6 feet high. Bed roughness is also provided by boulders, with a visually bi-modal mobile bed consisting of cobbles and fine gravel. We measured a 2 cfs low flow discharge in segment 9. Less instream wood was observed in segments 8 and 9 than in segment 5.

Habitat Conditions: The segments within this unit were not quantitatively sampled. Segments 5, 8 and 9 were visited and qualitative observations were noted. Bank vegetation is dominated by dense shrubs and forbs providing cover and leaf litter inputs. Pool habitat is provided within step-pool complexes. Pools appear common and are moderately deep. Suitable patches of sorted spawning gravels for small resident fish (0.1 to 1.0 inches) are virtually absent due to the mix of larger cobbles with coarse sand. Larger substrate particles are present, and the small boulder piles provide some interstitial spaces for winter refuge and rearing. LWD functions to retain spawning gravel, form pools, and provide cover.

Segments: *Field verified*: 5, 9
Reconnaissance: 8

Conditions and Response Potential:

Coarse Sediment: Coarse sediment deposits behind wood steps, but storage is limited due to steep gradients and valley confinement. Sources for larger particles are limited to bank erosion and extremely infrequent landslides within this lower portion of the watershed. Sources for the fine gravel fraction are abundant upstream. Substantial increases in the larger particle sizes are unlikely, but could temporarily widen the bed behind the steps and store in small bars. Increases in the fine gravel fraction would contribute to the poor sorting and embedding of spawning gravels and winter rearing habitat in the step reaches, but much of it is easily mobilized during moderate flows. Boulders are not frequently mobile. *Moderate sensitivity/vulnerability*

Fine Sediment: Fines in the coarse sand size were found only locally in slack water areas and within some pools in the steps. As discussed in the coarse sediment section above, increases in this size sediment will contribute to filling of interstitial spaces within the step reaches and some pool filling. Much of this sediment is transported downstream during moderate to high flows. *Moderate sensitivity/vulnerability*

Peak Flow: Wood and debris jams form within this unit. The large debris jam described above along with a concentrated deposit of large wood above the high water margins in segment 5 provide evidence of the capacity of the stream to transport LWD through these segments. Peak flow increases may increase the mobility or redistribution of in-channel wood. Channel impacts were localized. *Moderate sensitivity/vulnerability*

Large Woody Debris: LWD is critical in providing the step-forming structure in these segments. Wood steps create scour pools, trap sediment usable for spawning, and provide cover. In the absence of wood, boulders will provide cascades and loosely organize in smaller steps, but the amount and complexity of habitat will be greatly diminished. *High sensitivity/vulnerability*

Riparian Vegetation: Bank erosion is low. Although protection from erosion is provided primarily by bedrock banks, boulders, and LWD, standing riparian trees aid in both log jam formation and attentuating dam break channel damage and do provide bank protection and pool scour in the lower gradient steps. *Moderate sensitivity/vulnerability*

Dam breaks: Evidence of the break up of a debris jam was observed in segment 5, although the impact was localized due to the trapping affect of standing riparian trees. No evidence of catastrophic or long runout damage was noted in the field or from photographs. *Moderate sensitivity/vulnerability*

6a. Tributary connected wetlands with potential access to fish

Description: This collection of very low-gradient segments (<1%) are found in the tributaries of Onion Creek in the valley bottoms or, in the case of Quinns Meadow (segment 314), on a gentle, till-buried ridge. These segments may include a short section of defined channel outlet. These features are topographically derived and are generally areas of springs. Segment 712 (and possibly 706 and 709) has a complex of beaver dams and ponds. It is questionable if segment 712 has a surface water outlet, but was included in this unit because of proximity to potential fish-bearing channels and possible seasonal access. Open water areas vary from 2 to 7 acres. All are classified as non-forest wetlands (Water Quality assessment), and substrates are assumed to contain fines and organics.

Habitat Conditions: Without field verification, these segments are assumed to have seasonal access to fish. The outlet channel at Quinns Meadow was dry during field work in early October. These areas may provide refuge from high flows, and the wetland ponds could provide some rearing habitat.

Segments:	*Field verified:*	703, 903 (from 6b)
	Team notes:	314, 712
	Extrapolated:	706, 709

Conditions and Response Potential:

Coarse Sediment: Coarse sediment usually has deposited prior to reaching these low gradient segments or will deposit close to the source, which may diminish some wetland capacity but should not change the essential morphology. *Low sensitivity/vulnerability*

Fine Sediment: Wetlands are natural settling ponds for fine and suspended particles. A large increase in fines may significantly reduce the wetland volume over time and is dependent on the rate of background fine-filling, volume of the wetland, and volume of management-induced sedimentation. *Moderate sensitivity/vulnerability*

Peak Flow: Wetlands provide a low energy, backwater environment rather than the scour potential of concern in this rating. Peak flow increases will merely flood a larger area. *Low sensitivity/vulnerability*

Large Woody Debris: LWD provides no morphologic function except contributing to organic filling of the wetland. However, it could provide cover for fish. *Moderate vulnerability*

Riparian Vegetation: The amount of vegetation in and surrounding the wetland is a function of the ponded water depth and area. Wetland vegetation provides cover for fish. *Moderate vulnerability*

Dam breaks: Some of these wetland segments are controlled by beaver dams. Upon draining, the wetland size is greatly reduced and may return to a single, low-gradient channel. This is a natural cycle of wetland function. Both pre- and post-beaver dam conditions provide habitat for fish. *Low sensitivity/vulnerability*

6b. Tributary wetlands unconnected to fish streams

Description: The wetlands in this unit are similar to unit 6a but include only those low-gradient wetland features that are not directly accessible to fish, but have a surface water connection to the stream system of Onion Creek. For a complete listing of all wetland features in the WAU, refer to the Water Quality assessment. These segments function as sediment sinks between upslope sources and fish-bearing channels below. Segment 703 has been artificially drained with a road fill built through the middle of it and, according to the Steven County Soil Survey, segment 805 soils are drained as well. Artificial draining of headwater wetlands may contribute to lower summer flows or lower flows earlier in the year in the downstream channels. Segment 903 occupies a wet swale and is ponded just upstream of a road fill. Low flow outlets to these wetlands may be dry. Segment 904 occupies a depression on the Columbia River terrace with no surface outlet. Subsurface drainage from 904 is probably the spring source for segment 903.

Habitat Conditions: Wetlands in this unit were determined to have no direct access to fish or provided insufficient habitat conditions.

Segments: *Field verified*: 703, 903
Extrapolated: 52, seg. above 203, 805, 904, 808

Conditions and Response Potential:

Coarse Sediment: Coarse sediment usually has deposited prior to reaching these low gradient segments or will deposit close to the source, which may diminish some wetland capacity but should not change the essential morphology. *Low sensitivity*

Fine Sediment: Wetlands are natural settling ponds for fine and suspended particles. These low-gradient reaches provide sediment storage between upstream sources and fish-bearing streams where they are connected. *Low sensitivity*

Peak Flow: Wetlands provide a low energy, backwater environment rather than the scour potential of concern in this rating. Peak flow increases will merely flood a larger area. *Low sensitivity*

Large Woody Debris: LWD provides no morphologic function except contributing to organic filling of the wetland. *Low sensitivity*

Riparian Vegetation: The biologic function of wetland vegetation is considered within the Water Quality assessment. *Low sensitivity*

Dam breaks: Some of these wetland segments are controlled by beaver dams. Upon draining, the wetland size is greatly reduced and may return to a single, low-gradient channel. This is a natural cycle of wetland function. *Low sensitivity*

7. Tributary, 1-2%, moderately confined

Description: Unit 7 includes the low gradient, moderately confined perennial tributary segments. These are similar to the mainstem unit 2 segments, but are separated because of their smaller size. Measured bankfull widths vary from 5 to 10 feet. Channels are moderately confined within gentle swale or terrace topography within the larger valley. Forced pool-riffle bed morphology is dominant. Glacial-lag boulders were observed by the riparian analyst to provide some structure in segment 705. Bed particle sizes are in the coarse gravel range, with a large component of the very coarse granitic sand. The upper to mid-portion of segment 601 appears recently disturbed as the channel is wide and shallow (10 feet wide by approximately 0.3 feet deep), lacks much structural integrity and has recent and extensive overbank silt deposits. Plane bed topography dominates this disturbed portion. Discharge measured at the lower end of 501 was 0.9 cfs, and 0.4 cfs at the lower end of 601. As the flow in 601 appears larger in volume further up in the segment, flow is probably immergent in the lower part. A local swimming hole had been created below the county road crossing on segment 501, and the structure appears temporary. Segment 501 and adjacent segments appear bright and disturbed in the 1968 photos due to an apparent tailings pipe/slope failure upstream.

Habitat Conditions: Segments 501, 601, and 701 were visited and qualitative observations were noted and LWD counts were taken. Bank vegetation is composed of alder, shrubs, and grasses which provide cover and leaf litter inputs. Pool habitat was not evaluated. Substrates are a mix of coarse gravel and coarse sands with some glacial lag boulders which provide some structure and potential winter rearing habitat in segment 705. LWD is the primary pool forming element and is lacking in segments 501 and 601.

Segments: *Field verified*: 501, 601
Team notes: 705

Conditions and Response Potential:

Coarse Sediment: An oversupply of coarse sediment would overwhelm these small channels, burying wood and other structures, filling pools, cause widening and shallowing of the bed, and may cause subsurface flow during low flow conditions. Overbank gravels were observed above the road crossing on segment 501. *High sensitivity/vulnerability*

Fine Sediment: These low energy channels will tend to store fines in both the bed and pools. Low flows were measured at less than 1 cfs in segments 501 and 601. There is a high component of coarse sand within the mobile bed. Extensive overbank silt was noted in mid-segment 601. *High sensitivity/vulnerability*

Peak Flow: The effect of increases in peak flows is highly dependent on the condition of other channel elements. With stable LWD and adequate riparian vegetation, some channel reorganization and bank erosion would be expected; however, flows should be accommodated within the larger vegetated floodplain. Since peak flows should be overbank, little additional depth and velocity within the channel should be expected. Where bank vegetation has been removed, channel widening, shallowing, and bed coarsening would be expected. *Moderate sensitivity/vulnerability*

Large Woody Debris: LWD appears critical to the structural complexity of these channels. Wood is the main pool-forming element. Where wood is lacking in segment 601, the bed widens, shallows, and becomes a long riffle. LWD also contributes to bank protection. Local residents living along the stream may remove wood in segment 501 in order to enhance visibility, access, and drainage. *High sensitivity/vulnerability*

Riparian Vegetation: Alder and shrub roots are the main bank protection and create undercut banks that provide fish cover and holding. Clay banks observed in lower segment 601 are resistent to erosion and promote pool development. *High sensitivity/vulnerability*

Dam breaks: No beaver dams were observed in the field, although it is probable beaver occur in these areas. Due to low gradients and vegetated floodplains, the resulting flood wave from a dam break would attenuate quickly. Localized bank erosion and channel rearrangement could result. *Moderate sensitivity/vulnerability*

8. Tributary, 2-4%, moderately confined

Description: Unit 8 includes perennial tributary segments slightly higher in gradient than unit 7. These are small channels with bankfull widths between 3 and 6 feet in the surveyed and sampled segments. Segments 502 and 503 are exceptions with measured bankfull widths between 8 and 14 feet. A moderate valley confinement is provided by till-covered sideslopes. Segments 202 and 502 are more constrained by roads parallel to the channels. Many of the surveyed and observed segments contain boulders in the bed assumed to be infrequently mobile and eroded from the glacial till soils. The mobile bed consists of coarse sand and fine gravel of granitic origin. Bed textures in the wider segments contained cobbles in addition to the gravel and sand, although the coarser bed in segments 502 and 503 may also be a function of disturbance originating upstream along with the road bed confinement. Gradients range from 2 to 4 percent, but segments 202 and 305 have gradients as high as 6 to 8 percent. These segments are included in this unit because bed textures are more similar to other segments in unit 8 than unit 9. The dominant bed morphology is pools and riffles forced by wood, boulders, and banks. Wood and boulder step pools and plane beds were also observed. The lag boulders help to trap small debris jams observed in segments 201 and lower 701, but were also found to suspend wood in upper segment 701. Lacking wood, unit 8 channels retain enough structure from boulders to retain some pool forming and sediment trapping capability. A low flow discharge of 0.6 cfs was measured in segment 701.

Habitat Conditions: Segment 502 was the only segment where habitat conditions were quantitatively sampled. Habitat conditions are generally fair to good. Bank vegetation consisted of shrubs and forbs which provide cover and leaf litter inputs. Pools are frequent and moderately deep. Suitable patches of sorted spawning gravels for small resident fish (0.1 to 1.0 inches) are present on channel margins. Groups of brook trout indicated spawning may be taking place in this area. Larger substrate particles were 40 to 50 percent embedded resulting in few interstitial spaces for winter refuge and rearing. LWD functions to form pools and cover. Segments 701 and 801 had bank vegetation consisting of young hardwoods and conifer and grass which provides undercut banks. In some reaches the grass choked out the channels. Sediment conditions were dominated by sand and coarse gravels. LWD in channel is fair in mid-segment 701. In some cases, LWD was suspended over the small channels limiting LWD function and inputs.

Segments:	*Field verified:*	202, 502, 503, 801, 701
	Reconnaissance:	201, 205, 305, 402, 702, 803
	Extrapolated:	708

Conditions and Response Potential:

Coarse Sediment: The beds are composed of fine gravel and sand in the smaller channels, and cobble sand/gravel in the wider channels. An oversupply of the coarser sediment would overwhelm these small channels, burying wood and other structures, filling pools, and cause widening and shallowing of the bed. *High sensitivity/vulnerability*

Fine Sediment: Since the bed textures are high in sand-size fines, additional inputs will have a similar effect as in coarse sediment above. Airborne silt from the adjacent road dust was found to cement the gravel bed in segment 202. Angular and flat slate gravel lends to packing of the bed as well. *High sensitivity/vulnerability*

Peak Flow: The effect of increases in peak flows is highly dependent on the condition of other channel elements. With stable LWD and adequate riparian vegetation, some channel reorganization and bank erosion would be expected; however, flows should be accommodated within the larger vegetated floodplain. Since peak flows apread horizontally overbank, little additional depth and velocity within the channel should be expected. Under disturbed conditions where bank vegetation has been removed, channel widening and shallowing, bed coarsening, and bed scour would be expected. *Moderate sensitivity/vulnerability*

Large Woody Debris: Unit 8 channels differ from unit 7 channels primarily in that most of unit 8 channels will retain some structure from boulders in the absence of wood in the system. During low flows, however, the streams flow around rather than over the boulders. LWD was observed to contribute to the structural complexity of these channels by forming small steps and scour pools, trapping and sorting gravel, protecting banks, and providing cover habitat. Where wood and boulders are lacking in segment 502, the bed widens, shallows, and becomes a long riffle. *High sensitivity/vulnerability*

Riparian Vegetation: The roots of riparian vegetation are the primary sources of bank protection in the observed segments. Wood and boulders provide secondary protection. Where riaprian shade is lacking in segments 701 and 702, the channels are choked with grasses. *High sensitivity/vulnerability*

Dam breaks: No beaver dams were observed in the field checked segments, although it is probable for beaver to use these areas. Due to low gradients and vegetated floodplains, a flood wave resulting from failure of aa small impoundment would attenuate quickly. Localized bank erosion and channel rearrangement could result. *Moderate sensitivity/vulnerability*

9. Tributary, 4-12%, confined

Description: Unit 9 includes perennial tributary segments within a broad range of 4 to 12 percent gradients. All of these segments have a dominant step-pool morphology and developed within deep, glacial till or terrace soils in midslope to footslope locations. Valleys are generally confined, although some gentle swale topography allows for more moderate confinement. Measured bankfull channel widths are highly variable between 3 and 11 feet and locally higher. Short sections of low-gradient reaches were found in segments 311 and 510. Breached beaver dams were found in segments 509 and 510. Man-made impoundments are also found within this unit in segments 301 and 509, and others may also exist. Boulders and wood steps provide the step structure, and the mobile bed consists mainly of fine to coarse gravel and small cobble. Perennial flow may originate from springs at the upper ends of some of these segments (607, 311, 207).

Variants: Segment 204 was dry during early October field work, but is included in this unit because a well-defined channel and water in segment 205 upstream suggest this segment flows on a regular basis and fish may have seasonal access. Segment 512 drains shallow soils on bedrock slopes and has gradients in the 6 to 20 percent range. It is included in this unit because of perennial flow confirmed during field surveys, and meets the criteria for new Type 3 water typing.

Habitat Conditions: The extension of the defined fish-bearing streams from the FPB emergency rule includes a number of unit 9 segments. As a result, a number of roads previously crossing Type 4 and 5 streams may now be potential fish barriers.

Fish (brook trout) observations were more common in segment 509 and 505 than any other segments visited. Habitat conditions are generally fair to good and varied depending on gradient. In segment 509, bank vegetation consists of shrubs and forbs which provide cover and leaf litter inputs. Pools are frequent and moderately deep. Suitable patches of sorted spawning gravels (0.1 to 1.0 inch) are present in patches on channel margins. Groups of brook trout suggested spawning may be taking place in this area. Larger substrate particles are 40 to 50 percent embedded resulting in few interstitial spaces for winter refuge and rearing. LWD functions to form pools and cover. LWD function and supply appears to be influenced by dam break flooding associated with upstream beaver dam complexes. Segment 505 is a higher gradient step-pool complex. Pools, spawning gravels and general fish habitat are maintained by the presence of LWD.

Segments:	*Field verified*:	509, 505
	Reconnaissance:	204, 301, 311, 401, 506, 507, lower 510, 602
	Team notes:	204, 207, 311, 401, 506, 512, 602, 603, 604, 605, 607
	Extrapolated:	upper 510, 511, 606, 707, 710, 711

Conditions and Response Potential:

Coarse Sediment: Although these segments contain steep streams, the mobile bed is mainly in the large to small gravel range. This is a function of the sediment load, the small size and energy of the streams, and the step morphology which will tend to store smaller particles in the low gradient steps. Very coarse sand and fine gravel is also a major component of the local till soils and is carried in the bed. Increases in coarse sediment would temporarily fill pools. However, it would take an extreme volume of this material, as observed in segment 506 above the Section 28 road crossing, to cause significant or long term changes. *Moderate sensitivity/vulnerability*

Fine Sediment: Fines less than 2 mm were not observed to be overly abundant on the bed of these small, steep streams, although overbank silt deposits were noted above the road fill in 507. Some pools have patches of fine gravel that, when sorted or clean, make appropriate-sized spawning gravel for the small resident fish. An increase in fines less than 2 mm, however, may fill the interstitial spaces in these small gravels. *Moderate sensitivity/vulnerability*

Peak Flow: Peak flows are currently accommodated within the banks and limited floodplain available in these confined channels. Some additional bank erosion, overbank deposits, and pool scour may be expected with peak flow increases over the range of flows under undisturbed conditions. Overbank silt deposits were noted in segments 507 and 510 in the lower gradient steps. Most wood and boulder roughness would continue to function to dissipate energy and provide refuge habitat at high flows. *Moderate sensitivity/vulnerability*

Large Woody Debris: Segment 505 provides a dramatic example of channel changes in the lack of LWD in unit 9. Bed morphology is step pool immediately above an assumed pipeline burst visible in the 1968 photos that heavily gullied a slope above the stream, while immediately below is a boulder cascade reach. The step-pool features provide scour pools for fish holding and pocket gravels for spawning. Fish habitat is greatly reduced in the absence of LWD. Segments 602 and 505 have larger channels due to a larger drainage area and/or flow, and the observed functional wood size was larger than in the smaller channels. Wood is particularly critical in segment 602 where the source soils appear to be lacking in boulders. *High sensitivity/vulnerability*

Riparian Vegetation: Although there are boulders and wood within these small streams, field notes on segments 204, 401, 505, and 602 indicate that tree roots are primary or secondary factors in controlling bank erosion. Streamside riparian trees also provide roughness upon which wood steps may form and is important for maintaining the habitat diversity in these steep streams. *High sensitivity/vulnerability*

Dam breaks: Since beaver dams and impoundments are located within these channels, the potential for dam break exists. Evidence of dam break was found in segment 509 where extensive, localized downcutting and bank erosion had occurred. It was unclear whether this event was related to an upstream beaver dam breach, as channel manipulation was also evident in the immediate area. No photographic or field evidence was found to indicate that these processes occur frequently or affect extensive lengths of the channel. *Moderate sensitivity/vulnerability*

10a. Tributary, 4-12%, midslope ephemeral or intermittent streams connected to Type 3 streams, moderately confined to confined

Description: Unit 10a channels include a variety of ephemeral or intermittent streams draining midslope locations underlain by deep glacial till. Gradients are in the moderate to moderately steep range of 4 to 12 percent. The majority of these segments have defined channels indicating surface flow for some part of the year. Portions of these segments may have ill-defined channels or wet swales where surface flow is intermittent. Channels are moderately confined in swales or confined by moderate gradient slopes. Bankfull channel widths vary from less than 1 foot to 3 to 4 feet. Bed morphologies include plane bed, step pool, and forced pool-riffle. Mobile bed textures include medium to fine gravel, sand and silt. Some channels contain boulders eroded from the adjacent till soils.

Segment 203 is essentially a road ditch. It is doubtful that this channel contained much surface flow prior to construction of the road grade within this narrow swale. The result has been a displacement of the absorption and filtering function of the swale. Both the road surface and the ditch drain directly into a stream channel.

Habitat Conditions: These channels lack sufficient flow to provide suitable habitat for fish.

Segments: *Reconnaissance*: 203, 304, 306, 508, 802, 804
Extrapolated: 51, 104, 105, 206, 302, 303, 307, 308, 309, 310, 313, 403, 404, 504, 608, 801-4, 806, and 36 unnumbered segments

Conditions and Response Potential:

Coarse Sediment: Since these channels are not fish-bearing, their main function is to store and meter sediment out to downstream reaches. Coarse sediment will deposit behind obstructions. Coarse sediment above medium-sized gravel may not be transported by these streams. Segments 304 and 804 below road outfall has extensive deposits of fine gravel and fines in the dry bed. *Low sensitivity*

Fine Sediment: Fine sediment of all size fractions are found on the dry channel beds. During higher flows, many of the smaller fines will transport through. *Low sensitivity*

Peak Flow: Peak flow increases in these small streams may occur from increases in road runoff. These small channels could widen and erode to accommodate the added flow. The extent of erosion is dependent on the amount of flow obstructions and riparian vegetation. With sufficient flow obstructions from forest litter, wood, or riparian roots and vegetation, erosion may be minimal. *Moderate sensitivity*

Large Woody Debris: Woody debris traps sediment and reduces flow energy, and therefore erosion. The roots of standing trees and falling branches are more likely to function within these small channels than entire downed trees. *Moderate sensitivity*

Riparian Vegetation: Roads can add relatively significant ncreases in channel forming runoff to these small channels (see Peak Flow). Tree roots, standing shrubs, forbes and grasses all function to prevent bank ersoion, which mitigates downstream sediment delivery to fish-bearing streams. A certain amount of storage capacity is also provided by obstructions in the lower gradient channels. *High sensitivity*

Dam breaks: These small channels with seasonal flow are unlikely to form significant obstructions. Beaver dams were not noted in the field checked segments. *Low sensitivity*

10b. Tributary, 4-12%, midslope ephemeral or intermittent streams unconnected to Type 3 streams, moderately confined to confined

<u>Description</u>: Unit 10b channels differ from 10a channels only in that they do not have a surface water connection to the fish-bearing streams. Segments 902, 909 and 910 terminate in unconnected wetlands. Segments 50, 102, 103 and other unnumbered segments have no apparent surface connection with the mainstem at their terminal ends.

<u>Habitat Conditions</u>: These channels lack sufficient flow to provide suitable habitat for fish and are not accessible from fish-bearing streams.

<u>Segments</u>: *Reconnaissance*: 102, unnumbered segment in NE4 of NW4 Sec 14 T38R39
Extrapolated: 50, 53, 103, 906, 907, 909, 910, and 15 unnumbered segments

Conditions and Response Potential:

Coarse Sediment: These channels are seasonal conduits for runoff and will transport and store coarse sediment. In channel and downstream impacts from increases in coarse sediment are of no consequence to fish habitat or water quality. *Low sensitivity*

Fine Sediment: These channels are seasonal conduits for runoff and will transport and store fine sediment. In channel and downstream impacts from increases in fines sediment are of no consequence to fish habitat or water quality. *Low sensitivity*

Peak Flow: Peak flow increases from increases in road runoff may increase erosion in these small streams; however, there are no impacts to fish or water quality. *Low sensitivity*

Large Woody Debris: Wood and forest litter provide obstructions for sediment storage and dissipation of flow energy, but are not essential in maintaining fish-habitat or water quality. Other off-site impacts to private property downstream may need to be considered. *Low sensitivity*

Riparian Vegetation: Roads located in swales or displacing ephemeral channels were observed to reduce the absorption and filtering function of the soils and vegetation, and have the potential to establish a surface water connection to fish bearing streams. *Moderate sensitivity*

Dam breaks: These small channels with seasonal flow are unlikely to form significant obstructions. Beaver dams were not noted in the field checked segments. *Low sensitivity*

11a. Ephemeral or intermittent headwater channels, connected to Type 3 streams

Description: Channels in the headwater-connected unit originate on the steeper upper basin slopes underlain by bedrock at shallow to moderate depths (0 to 40 inches). Many of these small drainages flow through the deeper till and terrace soils at the foot slopes and flow subsurface. These channels are generally not spring-fed or have insufficient flow to create a perennial stream. Some may flow intermittently in the low-flow months before going subsurface. Others receive runoff only during snow melt periods. Unnumbered channels above segments 507, 603, 604, and 605 may have perennial flow. Channel gradients are 20 percent or greater, but include the lower gradient downstream portions of these channels, generally no less than 8 percent. Most have a small, but defined channel created mainly by snow melt runoff in the spring. Measured bankfull channel widths ranged from less than 2 feet to 4 feet.

Variations: Although shown on the soils map to drain deep, till-covered slopes, segments 106 and 109 are included in this unit due to gradients steeper than those generally found in unit 9. Segment 109 was also found to be flowing during early October field work.

Habitat Conditions: Channels in this unit may occasionally be utilized by fish but are generally not suitable for fish due to lack of perennial flow and steep gradients.

Segments: *Field Reconnaissance*: 107, 108, 109, 902, segment above 207, NE4 Sec 34 T38R40

Extrapolated: 106, 110, 312, and 40 unnumbered segments. Many similarly located and mapped channels were found to have no defined channel when field checked, and were removed from the channel map. Unfield checked segments of unit 11a are shown by a dashed line on Map E-1.

Conditions and Response Potential:

Coarse Sediment: Coarse sediment will deposit behind obstructions. These small, steep streams are transporting mainly gravel and sand. *Low sensitivity*

Fine Sediment: Mainly sand and silt-size fines were found on the dry channel beds. During higher flows, many of the smaller fines will transport through. *Low sensitivity*

Peak Flow: Peak flow increases in these small streams may occur from increases in road runoff. These small channels could widen and erode to accommodate the added flow. The extent of erosion is dependent on the amount of flow obstructions and riparian vegetation. With sufficient flow obstructions from forest litter, wood, or riparian roots and vegetation, erosion may be minimal. *Moderate sensitivity*

Large Woody Debris: Woody debris traps sediment and reduces flow energy, and therefore erosion. Boulders, roots of standing trees, and falling branches are more likely to function within these small channels than entire downed trees. *Moderate sensitivity*

Riparian Vegetation: Tree and shrub roots function along with boulders and wood to prevent bank ersion important for mitigating downstream sediment delivery to fish-bearing streams. *Moderate sensitivity*

Dam breaks: No field or photographic evidence of dam break or debris flow activity was noted in these steep channels. *Low sensitivity*

11b. Ephemeral or intermittent headwater channels, unconnected to Type 3 streams

Description: Channels in the headwater-disconnected unit originate on the upper basin steeper slopes underlain by bedrock at shallow to moderate depths (0 to 40 inches). Most of these small drainages flow through the deeper till and terrace soils at the foot slopes and flow subsurface or pond in disconnected wetlands. Channel gradients are generally greater than 20 percent, but include the lower gradient downstream portions of these channels. These channels are generally not spring-fed or have insufficient flow to create a perennial stream. Some may flow intermittently before going subsurface. Most have a small, but defined channel created mainly by snow melt runoff in the spring. Measured channel widths ranged from 2 to 5 feet.

Habitat Conditions: Channels in this unit are not suitable for fish due to lack of perennial flow, gradients greater than 20 percent, and are unconnected to any fish-bearing streams.

Segments: *Field verified*: 101, 704, 713, 901, unnumbered segment in Sec 25 T39R39.
Extrapolated: 905, 911, 912, 913, and 33 unnumbered segments. Many similarly located and mapped channels were found to have no defined channel when field checked and were removed from the channel map.

Conditions and Response Potential:

Coarse Sediment: These channels are seasonal conduits for runoff and will transport and temporarily store gravel and cobble-size coarse sediment. In-channel and downstream impacts from increases in coarse sediment are of no consequence to fish habitat or water quality. Other off-site impacts, such as culvert plugging and fill gullying downstream, may need to be considered. *Low sensitivity*

Fine Sediment: These channels are seasonal conduits for runoff and will transport and store fine sediment. In-channel and downstream impacts from increases in fines sediment are of no consequence to fish habitat or water quality. *Low sensitivity*

Peak Flow: Peak flow increases from increases in road runoff may increase erosion in these small streams; however, there are no impacts to fish or water quality. Other off-site impacts to private property downstream may need to be considered. *Low sensitivity*

Large Woody Debris: Wood and forest litter provide obstructions that limit erosion, but are not essential in maintaining fish-habitat or water quality in these unconnected streams. *Low sensitivity*

Riparian Vegetation: Tree and shrub roots function along with boulders and wood to prevent bank ersoion and can create obstructions for sediment storage and energy dissipation, but is not contributing to the maintenance of fish-habitat or water quality in these unconnected streams. *Low sensitivity*

Dam breaks: No field or photographic evidence of dam break or debris flow activity was noted in these steep channels. *Low sensitivity*

5.0 MONITORING RECOMMENDATIONS

1. The extended fish distribution based on the new channel definitions in the FPB emergency rule has not been field verified. The capacity of these small stream channels to support fish is uncertain. Fish surveys would help test the validity of this new rule. In addition, the presence of native bull trout, or cutthroat in the Onion Creek WAU has not been documented. We have suggested it is unlikely native bull trout or cutthroat occur in the Onion Creek WAU because of the glacial history of the watershed and the barrier falls near the mouth. However, there has been extremely limited fish surveys and more extensive surveys would help to verify this assertion.

2. Potential fish barriers have not been field checked at road crossings on the channel segments extended as type 3 under the emergency rule. A determination of potential fish use in these segments may reduce the list of crossings to check for barriers.

3. Since there is uncertainty regarding the cause for a lack of sorted spawning gravel in Onion Creek, baseline data on bed particle composition is recommended in those reaches noted as lacking. Repeat measurements are recommended following major floods, large drought cyles, and major or local channel changes resulting from either disturbance events or enhancement. Additional data collected may include the angularity and lithology of medium-gravel size and larger particles. Analysis of data will quantify the abundance of certain particle sizes, the influence of local sediment sources, and effects of the flow regime on sediment size and distribution.

6.0 REFERENCES

Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph 6.

Cavander, T.M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckley) from the American Northwest. Calif. Fish and Game 3:139-174.

Coho, Carol, and Burges, Stephen J., 1993, Dam-break floods in low order mountain channels of the Pacific Northwest, Department of Civil Engineering, University of Washington, Water Resources Series Technical Report No. 138, 68 p.

Groot C. and L. Margolis 1991. Pacific Salmon Life Histories. UBC Press. Vancouver. BC. 564 pp.

Haas G. R. and J. D. McPhail 1991. Systematics and distributions of dolly varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Can J Fish Aquat Sci. Vol 48: 2191-2211.

Hickman, T. and R.F. Raleigh. 1982. Habitat suitability index models: cutthroat trout. US Department of the Interior, Fish and Wildlife Service FWS/ OBS-82/10.5.

Keller, E.A., 1971, Areal sorting of bedload material: the hypothesis of velocity reversal. Geological Society of Ameria Bulletin 82, pp 753-756.

Lisle, T., 1979. A sorting mechanism for a riffle-pool sequence. Geological Society of America Bulletin, Part II, 90, pp 1142-1157.

McPhail, J.D. and C.B.Murray. 1979. The early life history and ecology of Dolly Varden (Salvelinus malma) in the upper arrow Lakes. Department of Zoology and Institute of Animal Resources, University of British Columbia, Vancouver, British Columbia.

McPhail, J.D. and C.C. Lindsey. 1986. Zoogeography of the freshwater fishes of Cascadia (The Columbia system and rivers north to the Stikine) p 615-637. *In* C.H. Houcutt and E. O. Wiley (ed.) The zoogeography of North American freshwater fishes. John Wiley and Sons, New York, NY. 866 p.

Meehan, W.R., editor. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19.

Montgomery, D.R., J. M. Buffington, R.D. Smith, K.M. Schimdt, and G. Pess. 1995. Pool spacing in forest channels. Water Resources Research 31:1097-1105.

Overton C.K., J.D. McIntyre, R. Armstrong, S.L. Whitwell and K.A.Duncan.1995. User's guide to fish habitat: Descriptions that represent natural conditions in the Salmon River Basin, Idaho. USDA Forest Service Intermountain Research Station Gen. Tech. Rept. INT-GTR-322.

Raleigh, R. F. 1982. Habitat suitability index models: brook trout. US Department of the Interior, Fish and Wildlife Service FWS/ OBS-82/10.6.

Raleigh, R. F., T. F. Hickman, R.C. Solomon, and P. C. Nelson. 1984. Habitat suitability index models: rainbow trout. US Department of the Interior, Fish and Wildlife Service FWS/ OBS-82/10.24.

Rieman, B.E. and J.D.McIntyre. 1993. Demographic and habitat requirements of bull trout. United States Forest Service, Intermountain Research Station, General Technical Report INT-302, Boise, Idaho.

Selby, M.J., 1982, <u>Hillslope Materials and Processes</u>, Oxford University Press, New York, 264 p.

Shepard, B. K. Pratt, P. Graham.1984. Life histories of westslope cutthroat and bull trout in the upper Flathead River basin, Montana. Kalispell, MY: Montana Department of Fish, Wildlife and Parks. 85p.

Strahler, A., 1957, Quantitative analysis of watershed geomorphology, *Trans. Amer. Geophy.U.*, 38, pp. 913-920.

Washington Forest Practices Board, 1995, Board Manual: Standard methodology for conducting watershed analysis. Version 3.0.

Wydoski, R.S. and R.R.Whitney 1979. Inland Fishes of Washington.University of Washington Press. 219 p.